of disease in the higher plants, for they germinate and grow under the usual conditions of our summer weather, and penetrate and develope in and at the expense of otherwise healthy plants. Under these conditions it is only necessary to place the matured spores on the parts of the plants inhabited by the fungus to ensure its growth, and, in consequence, the disease. It is, however, even in these cases, evident that much must depend upon the peculiarities of the weather, etc., whether the host or the parasite is specially favored or repressed, and so whether or not the disease is seriously injurious.

Rust spores on young wheat leaves in spring time are as certain to germinate and penetrate the tissues as arsenic is to poison mammals. In this case development goes on but slowly however, unless specially favorable conditions occur for the parasite, when, in the latter case, it makes its presence easily recognized by the disastrous results too often witnessed. Smut in wheat is less affected by peculiar states of the climate. The spores send their germinal tubes into the tissues of the seedling plants; the fungus grows with the host, and finally, just before harvest time, matures its spores again in the aborted wheat grains. Blight-bacteria, again, need only to be introduced in few numbers into the living bark cells of a healthy pear tree, during ordinary Summer weather, to insure their reproduction and multiplication in myriad numbers, and the death of the invaded cells in consequence of their deleterious action. It is by on means true that plants must be in an enfeebled condition that such parasites may grow upon them. The very vigor of the host often adds, by furnishing more assimilable food, to the extreme development of the parasites.

On the other hand there are many fungi that only grow on the higher plants when these have been injuriously affected by something else, or when the conditions are peculiar and altogether unfavorable for their proper development or growth. Thus apples become "scabby" by a fungus belonging to the preceding class, but they often rot while hanging on the trees through the effects of other fungus never injurious to perfectly sound fruit with an unbroken skin or epidermis. Peaches rot upon the trees under the effect of a mould-like fungus which produces myriads of spores that readily float like dust in a dry atmosphere, but these do not germinate except in moisture, and, as their duration of vitality is very short, few succeed in reproducing the plant except during rainy weather, when one decaying peach may be a source of contagion for hundreds of others. There are too great numbers of leaf-dwelling fungi which only grow upon these organs when from old age or other causes they have lost their powers of existence through the diminution of their vital forces, so that the mycologist learns to look upon old and fading leaves for numerous specimens. In the descending scale we find vast numbers of still other fungi which only grow upon really dead organic matter; these however have no share in the title parasitic.

It may therefore be concluded that, in the struggle for existence, many species of fungi have acquired the physiological power of overcoming the defensive forces of certain higher plants in a state of health under ordinary conditions of plant life and growth, while others, truly parasitic in their nature, are obliged to seize upon favorable chances to take advantage of slight or serious misfortunes happening to their hosts, thus giving the kick to one already going down hill.

I have thus endeavored to point out some of the general truths of vegetable pathology as they appear to one who accounts himself a student but not a master of the subject. I enter the open gateway of a great field, and make little incursions here and there, gathering now and again from the abundance offered, material for many odd hours of microscopical work, which again furnishes "food for thought" when the lamp has been extinguished and the scalpels laid away. There is much room for many better workers, and much interest for those who will work.

CROTON WATER OF NEW YORK.

It is admitted on all sides that an improved supply of water for New York city, both in regard to quantity and quality is imperatively demanded by its citizens, and the subject in one form, will shortly be discussed by the legislature at Albany.

In regard to quantity, the solution appears a simple one, as the present supply is adequate for all legitimate purposes; in fact, if it were not for the great waste of water now practised, the supply would exceed all demands of the present population.

It is claimed by the "*Sanitary Engineer*" that this waste is due to imperfect plumbing, and the facts and figures given, show that such a supposition is, in part, correct. Every householder, however, knows that a wasteful use of the water, due to the whole supply of the city being at the command of every individual, must lie at the root of the evil.

Much printers ink has been wasted in printing proclamations from the authorities to the people, counselling economy in the use of the water, but the time has, perhaps, now arrived when the legislature should decide to employ some remedy and make radical changes in the method of distributing the supply.

The method of running the main supply direct into every house, is certainly the most primitive and least scientific or practical of all means at command. It is an inviation for waste and extravagance, and has proved an utter failure, as the means for thus distributing a supply are so defective that, while one family in a house can draw on the Croton river at will, others, less fortunate, on another level endure a constant water famine.

The whole evil of this imperfect distribution of the water could be remedied, if the supply were made by cisterns only. This system has always been in use in London and answers admirably. Every householder under this system has one or more cisterns filled twice daily, and is not restricted either to the number, capacity or location of the cisterns. Thus each householder pays *pro rata* for the actual amount of water he consumes annually, which, beyond doubt, is the only equitable method of charging a water rate. In the case of manufacturers a meter is substituted, if desired.

A natural accompaniment of this system is a universal high pressure of water throughout the city, which provides that cisterns in the highest part of every house shall receive its supply daily. This mitigates the evil under the present system, of pumping and carrying water above the first and second stories, now necessary in most houses in New York city.

The economy of the cistern system is self evident for no one would call for more water than he could legitimately use and increase the annual water tax. Thus a premium for economy rather than waste is offered. In a sanitary point of view many advantages are attached to the use of cisterns, as the large amount of impurities have time to subside and the water is consumed in an improved condition. It is usual to construct one of the cisterns with slate, which is reserved for drinking purposes.

The plea that such a system curtails the proper use of water has no foundation in fact. The writer lived in a house in London for many years, under this system of supplying water, and found he received not only abundance for family use, but sufficient to water a large garden. If the system here described were put in practice in New York city, and the plumbing perfected, the present supply of water would be found ample, and part of the money now proposed to be wasted in making new storage reservoirs might be profitably used in building pumping stations, which would give a high pressure of water to all the upper rooms in the city, and increase the efficiency of the means now at command for extinguishing fires.

In regard to the quality of the Croton water, we will give an analysis by Professor C. F. Chandler.

CROTON WATER--GRAINS IN U. S. GALLONS. (CHANDLER).

Soda	0.326
Potassa	0.097
Lime	0.988
Magnesia	0.524
Chlorine	0.243
Sulphuric acid	0.322
Silica	0.621
Carbonic acid	2.604
Organic and volatile matter	0.670

Calculating 100,000,000 gallons as the daily average water supply of New York city, the impurities would be as follows:

CROTON WATER. (CHANDLER). IMPURITIES IN 100,000,000 GALLONS.

	TONS.
Soda	2.319
Potassa	0.692
Lime	7.038
Magnesia	3.742
Chlorine	1.735
Sulphuric acid	2.300
Silica	4.429
Carbonic acid	18.600
Organic and volatile matter	4.785

We have the same authority for stating that the organic and volatile matter occasionally reaches 1.14 grains to the U. S. gallon.

It will thus be seen that the constituents of Croton water show it to be excellent as a water supply to a city, being unusually free from mineral matter and having no inorganic substance in excess to make it objectionable.

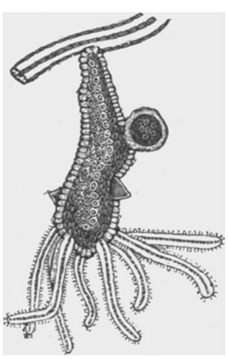


FIG. 2.
Hydra magnified.

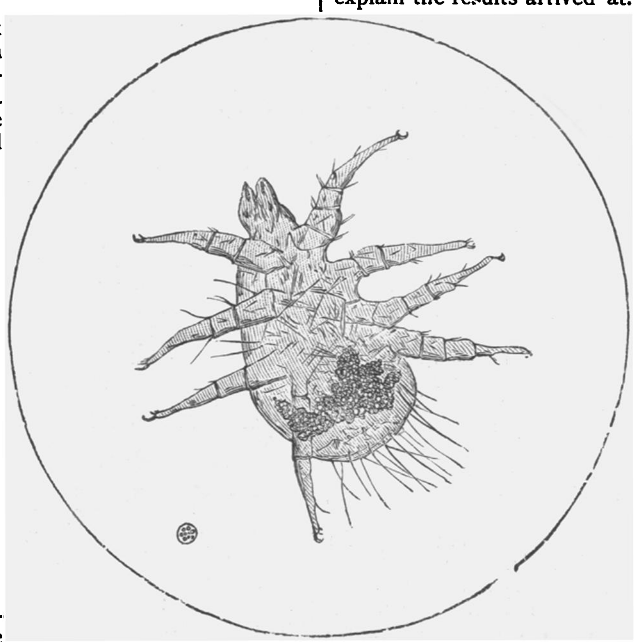


FIG. 1.
A parasite from some, bird or animal and foreign to the water. Seen for two weeks in countless numbers. They were all dead and surrounded by a jelly-like mass of putrescence.—(Michels.)

In discussing, therefore, the quality of Croton water it will be sufficient to confine our attention to the amount of organic matter it contains, and its nature.

To decide this point correctly a comparison of the analyses made by various chemists is desirable, but the greatest difficulties are here met, which are due to the erratic methods of those who have made and recorded these investigations. No two chemists appear to adopt similar methods of making analyses of water, and it is notorious that different methods give quite different results. On the other hand some chemists record their results in United States gallons, some in imperial gallons, and others in parts of 100,000,000, and others in 1,000 gallons.

From necessity rather than choice we will make an average amount of organic matter in Croton water from the following calculations:

	Tons in 100,000,000 gallons.
C. F. Chandler	4.785
E. Waller	18.324
Leeds	27.070
Herald	14.528
Average Tons in each day's supply,	16.176

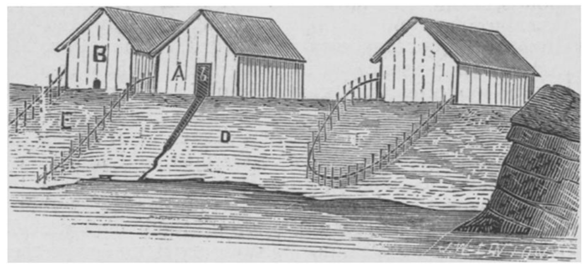


FIG. 4.
Whitlock's Slaughterhouse, showing drainage into Croton water supply.

To determine the nature of this organic and sedimentary matter a microscopical examination is necessary, and, as we have for nearly ten years continuously made such examinations, an attempt will be made to explain the results arrived at.

If a glass of Croton water freshly drawn be held up to the light, it will be noticed, that dispersed throughout

FIG. 3.
Hydræ natural size.

the water are very minute particles in countless numbers, which revolve as the water circulates round the glass, while here and there may be noticed (especially during the summer and autumn months), larger pieces having a reddish-brown color. If a piece of sponge is tied over the mouth of a faucet, and the water allowed to run for a short time, the sponge will be loaded in every pore with an accumulation of the impurities in the water. If the sponge is now squeezed in a glass, the water will be found to be opaque on account of the large amount of floating matter, it will emit a foul odor, and the resulting sediment will have the appearence of a foul blackish-brown slime. If a pipette is now used and some

of this deposit placed on a glass slide covered with a thin glass cover, and examined under a microscope, the field will be opaque with the dense nature of the impurities, but if diluted with a little fresh water, objects such as are drawn in figures—and—will be observed. These forms, which will be readily recognizable by microscopists, are composed of unacellular plants, very beautiful in form and mostly of a brilliant emerald green color. A nimallife is also well represented by forms usually found in stagnant ponds, from the purely microscopical forms to those visible with the naked eye; the hydra (figure) with its tentacles ready to grasp as its prey, the little crustaceans which are darting about.

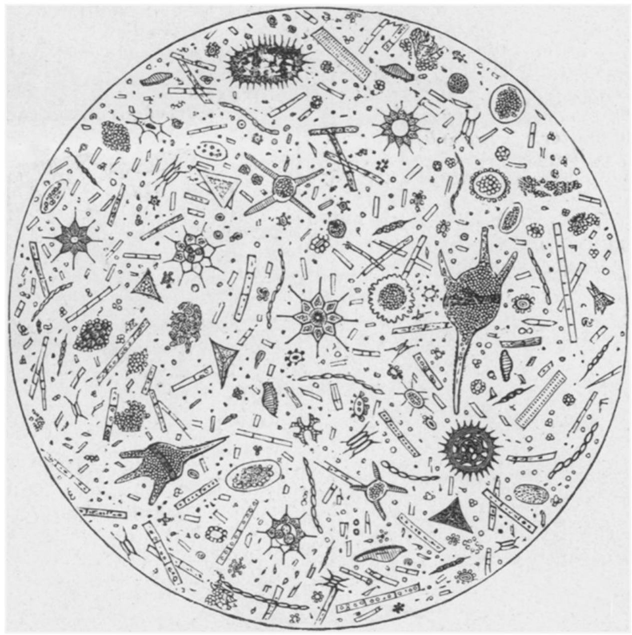


FIG. 5.
Living vegetable forms from the Croton water—(Michels.)

It is no part of this paper to describe these forms specifically, but the sanitary effect of their presence will be referred to in general terms. To prevent any misinterpretation I would state that the forms shown are not seen at a single view, but the contents of the circles represent forms which are all present in the Croton water, and may be seen by making several examinations of the deposit at different seasons. While such forms may be noticed, *the bulk of the deposit* is found to be composed of dead, rotten, and decayed matter (omitted from illustration to make place for more interesting forms) from which the living chlorophil has long disappeared; the larger fragments are of a dirty brown color, in some of which a growth of fungi may be noticed, indicating its antiquity. On an average from six to eight tons or even more of such contaminations mixed with dead, effete matter, is mingled with each day's supply to the city, and when at its worst gives the water that fishy, sickening odor, which in the height of the summer is always present in the Croton water.

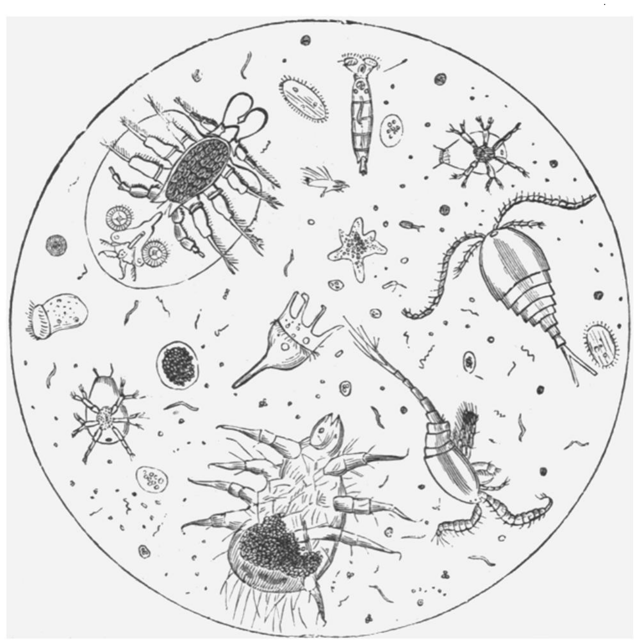


FIG. 6.
Animal organisms found in Croton water.—[Michels.)

With the exception of the eggs of entozoa I consider most the living forms I have noticed in the Croton water to be perfectly harmless in their living state; but they are continually undergoing a process of decay, die, and when dead they are very offensive in their odor, and when present in such numbers as found in Croton water, must contribute to foul the water.

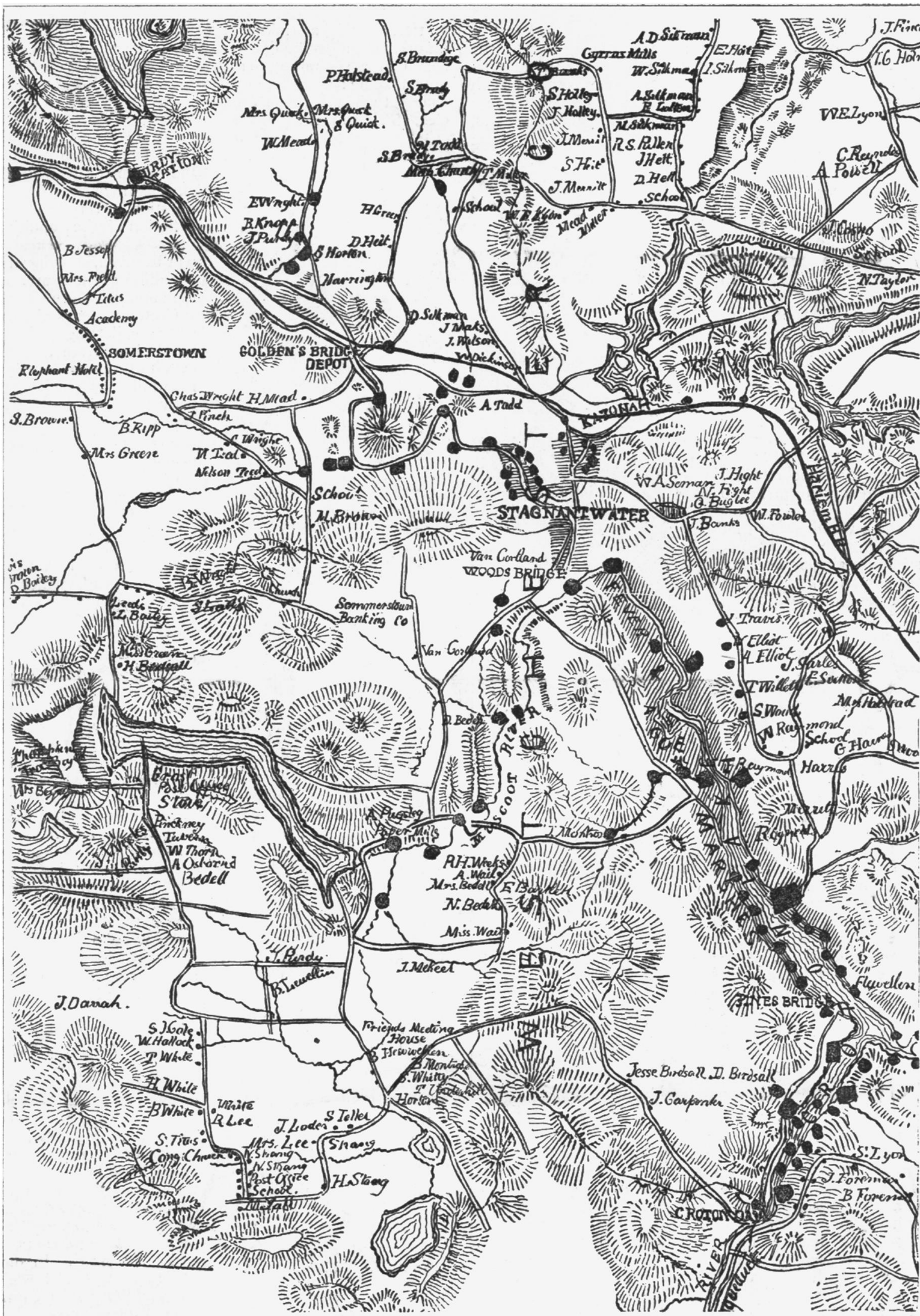
As I have stated, the bulk of the deposit is dead effete matter, forming a stinking slime which is repulsive in its nature, and must be dangerous to use as food. If collected in a spoon no person would swallow such black putrid slime; are therefore the conditions improved or changed when it is thinly dispersed in finely divided particles, so as to make its presence barely visible?

Where does all this filth come from which poisons the water of New York city? In answer to this question, a very brief description of the condition of the Croton water shed will be given, showing the condition of the source of the supply.

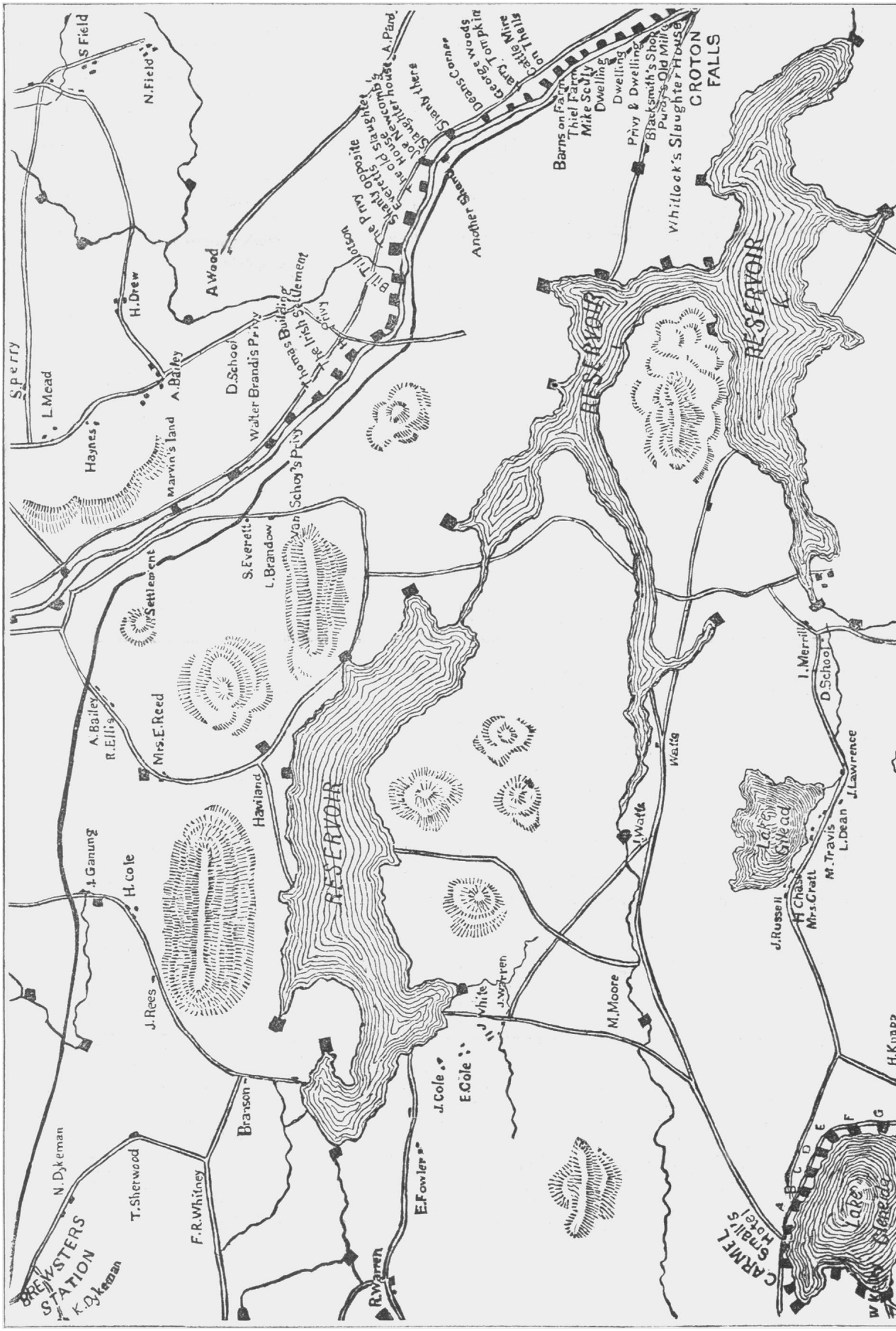
Croton water is the result of collecting the rain fall drained from a large extent of country covering forty miles, which is eventually stored in a series of reservoirs and lakes for future use. The borders of many of these lakes are very shallow and loaded with aquatic plants, and thus brought under the influence of the sun, which destroys the vegetation and converts it into a putrid deposit, which is broken up by the action of the water into fine particles, and eventually delivered at the faucets in our city.

Not long since the Croton lake and the source of the supply up to Croton dam was thoroughly surveyed by Mr. Robert Morris, for the New York *Herald*, whose report was confirmed later by Mr J. Y. Culyer, Engineer, of Prospect Park, Brooklyn, in a letter to the New York *Tribune*, and the *Sun*, *Times*, and *World* have all contributed to expose the state of things we shall now describe.

The report we refer to, states that even Croton Lake wore a green and stagnant look and its shores were sedgegrown, marshy, and laved by little streams that dripped down from barns, houses, hog-pens and farm yards. Various parts were covered with slimy grass, decomposed vegetable matter, and in parts the water was covered with a thick scum. Around other lakes he found stagnant water, fever and ague swamps, filthy drains, wayside sloughs, and on their banks cattle pens and dirty yards. In one place near Mr. Hyde's house, a hollow was found where every kind of rural filth had accumulated and decayed. On pushing his cane into the mass, a stench was stirred up that made him glad to give up further exploration in that direction.



MAP OF CROTON WATER SHED. SOURCE OF IMPURITIES MARKED BY BLACK SPOTS.



Part of Map of Croton Water Shed. Impurities marked by Black Spots.

In another place right across the whole face of the lake stretched half a dozen islands, affording no foothold for man or beast, surrounded by stagnant green water filled with every conceivable vegetable rottenness.

The sewers from farm houses, cottages of laborers and factories were noticed to draindirectly in the water supply; in fact the source of water supply of New York city was found to be a common drain for about 300 cattle yards, dwelling-houses, factories, pig-sties, slaughter-houses, and other sources of impurities, every one of which are distinctly shown on the maps we present, the exact location being indicated by a black spot. Space will not allow us to give futher evidence on this point which it is in our power to offer, but we present a cut of one of these sources of pollution, showing the direct drainage into the Croton water.

Of the danger of drinking such water full of the vilest contaminations we will not dwell, each reader can take his own course, but those who are prudent will both boil and filter it before using for drinking purposes. Individuals and journals still claim that the source of the supply is free from contaminations, and the water pure and fit for drinking purposes; to be consistent they have to say that the water is wholesome.

Professor Leeds of the Stevens Institute recently showed that the Croton water contained more organic volatile mattert han the water supply of Newark, which is taken direct from the Passaic with all the sewage of Paterson and other towns. He found the organic matter in 100,000 parts in New York water to be 6,50, Newark 6.00, Hoboken 4.50. At the February meeting of the American Chemical Society (see page of this number), Dr. E. Waller, of the New York Board of Health, endeavored to deny this startling statement, by producing analyses of his own, showing quite different results. We understand that at the March meeting of the same Society, Professor Leeds asserted to the satisfaction of the Society that Dr. Waller's methods were bad and had led him to error, while the integrity of his own analysis was established.

We consider the method of storing the water supply of a city in shallow, marshy lakes, in fever and malarious districts, to be wrong in principle, and that a radical change in the management of the water supply of New York City, rather than an expensive extension of it, to be the most prudent course to adopt at the present moment.

ELECTRIC CONDUCTION AND DISCHARGE.

By F. E. Upton.

The question of the nature and the vehicle of the electrical discharge is an important one, and its determination will contribute greatly to the solution of many interesting problems in cosmical physics. It is desired in this article to call attention to some recent advances that have been made in this direction.

The view that the phenomenon is one of pure conduction, though it has received the attention of eminent physicists, can be said to be no longer entertained.

When a conductor is made to connect two poles or electrodes which are at a different potential, it is well known that the greater the cross section of the conductor, or in other words, the more of the conducting material is laid bare by a cross section, the *less* resistance will be offered to the union of the electricities of the two terminals, and the greater will be the ensuing current, with a given E. M. F.

Now, in the discharge, the contrary is observed directly. This characteristic of conduction is absent when the discharge takes place; in a tube containing air, the greater the pressure (above a certain inferior limit), or the more of the conducting material there is laid bare by a cross section, the *greater* will be the resistance to the passage of the spark, and the nearer together the terminals will have to be brought to effect a spark with a given difference of potential. Sir Wm. Snow Harris, in 1834, made an attempt to grasp at the law governing the relation of the length of spark to pressure; and he then stated that the length of spark is in the simple inverse ratio of the pressure. Gordon, in 1878, made a series of experiments to test this law, (Elec. and Mag. II. 55-62). He found that from a pressure of about eleven inches to that of the atmosphere, Harris's law held approximately good.

Representing resistance by r, and matter laid bare by cross section by s, in the case of conductor $r = \frac{1}{s}$; in the case of discharge 92 of $r=s$, approximately. Thus there is in question two entirely different order of phenomena.

Another distinctive characteristic of conduction will be recognized in the fact that whenever there is any conductor at all, however small and however long it may be, connecting two poles, some degree of current will flow, as long as there is any difference of potential. With discharge, however, a certain lower limit of distance apart of poles, and of interposed matter, is requisite for any current at all, and when that limit is reached the spark passes, instantaneously, and the discharge commences.

Whether the current passes by conduction or discharge, heat is equally developed; in the conductor in the one case, and in the interposed matter in the other. This common development of heat does not in any way assimilate the two phenomena. The condition of affairs in the two cases will perhaps become obvious if recourse is had to the corresponding hydraulic analogy.

Imagine a pond of water held in place by a dam, with a pipe leading from the bottom of the dam, for the purpose of drawing water from the pond. The smaller that pipe is in section, the smaller will be the current of water flowing through it under a given head, and a certain amount of heat will be developed by friction of the water against the interior of the pipe; moreover some degree of current will flow as long as the pipe has any size of cross section at all. That corresponds to conduction. Now let the pipe be imagined closed to the exit of water; as long as the dam is sufficient, no current at all will flow; but suppose the dam be diminished in thickness gradually and constantly, a point will be eventually reached when it will no longer suffice to hold back the water, which will break through the impediment; the friction of the water against the fragments of the dam, and of those fragments against each other will develop heat as in the first case. That corresponds to the discharge.

By this analogy the difference between conduction and discharge is clearly apparent. A conductor between two points at a different potential never offers any *resistance* to the passage of the current, strictly speaking. Instead of saying that a slender wire offers more resistance than a thick one, it would give a better understanding of the matter to say of the latter that it offered a freer passage to the current than the former. In the case of discharge, on the contrary, the matter interposed between the points acts always as a bar, or resistance to be overcome, and the more there is of it the more resistance. It is never an aid or way.

Mr. E. Goldstein, in the *Annalen der Physik*, describes an ingenious experiment bearing upon this point, which, if not conclusive, is entitled to some consideration. In a discharge tube which was filled with dry nitrogen, he placed a little sodium, which could be vaporized by heating. The positive light had a purplish red color, but in the vicinity of the sodium it was of a golden yellow. By careful heating and manipulation, the upper half of the tube could be kept red and the lower half yellow. Now the tube was brought over and near, in a horizontal and equatorial position, to a powerful magnet. The discharge light was repelled as a slender thread to the opposite (upper) side of the tube; but it was a pure eddish thread, and showed no trace of sodium yellow.